

TAPPING OF THE LATERAL VENTRICLES.

By J. FRANK, M.D.,

OF CHICAGO,

SURGEON TO COOK COUNTY AND ST. ELIZABETH HOSPITALS,
AND TO THE HOME FOR AGED JEWS.

THE interesting train of symptoms, long known and recognized, of which the principal are nystagmus, general convulsions, disturbance of the respiration, slowness of the pulse, vomiting, coma, and death, find a solution in the acceptance of the theory of compromise of brain-function by so-called intracranial compression. Whether an actual elevation of intracranial pressure be present, or whether the symptoms have their foundation in irritation of brain-elements by increased transudation, concerns us less than the possibility of restoring brain-function in part or in whole by removing collections of cerebro-spinal fluid, blood, pus, or foreign matter. That this can be done practically upon the operating-table with the same gratifying results as in the experimental laboratory has become a well-known fact. It is, therefore, not strange that operators should have adopted means of reaching compressing agents in the lateral ventricles there known to exist.

Tapping for hydrocephalus through the fontanelle is so old a procedure that it cannot be determined who first devised or practised it. The publishing of the method for tapping the ventricles by means of trephining is of more recent date, and the plans for the same have been technically perfected and shown to be thoroughly feasible and easy of accomplishment.

Dr. C. Wernicke¹ writes of meningitis that the disease can "get well by spontaneous retrogression." It is, therefore, often necessary to lengthen life in every possible manner in order to give sufficient time that the chance of spontaneous retrogression

¹ Lehrbuch der Gehirn Krankheiten, Vol. III, 1881.

may obtain. It seems, in many cases, the cause of death is an effusion into the ventricles, which has the tendency to increase even when the disease is in the stage of retrogression. This can be clinically determined where the fontanelles are still open. Where this condition of things is plainly pronounced, operative interference is fully justifiable,—the more so, as without it a fatal ending can, with the greatest certainty, be predicted. In such cases one will trephine and puncture the lateral ventricles. The returning powerful pulsation of the brain will indicate if the intended result of the operation has come to pass. Where it is necessary there must be no timidity about repeating the operation, or eventually performing it on both sides.

D. Lowson, M.D., of Hull, on April 10, 1885, before a branch of the British Medical Association, read a paper, in which he recounts a case of hydrocephalus in a boy, seven years of age, paralyzed, blind, in constant pain, affected with occasional epilepsy, but intellect unimpaired. The skull was drilled, fluid aspirated, and constant drain established by means of silver cannula, to the end of which rubber tubing was attached, leading under carbolic acid fluid in a bottle placed lower than the head. Rapid improvement with some movement of limbs and some vision was noted. In his sleep patient pulled out the cannula twice. The last time it could not be found. Died comatose the day after, the eighth after operation. Silver cannula found in the ventricle.

Dr. Philip Zehner, of Cincinnati, in a paper on tumors of the brain, read before the Academy of Medicine, February 1, 1886, referred to tapping the ventricles as a palliative measure in some cases of tumors of the cerebellum, and reports a case in which the proposition to do the operation was circumvented by sudden death of the patient. The autopsy of the case made clear the certain benefit to be derived from such interference.

Ernst von Bergmann,¹ writing of the operative treatment of acute hydrocephalus from tubercular meningitis, states that "it is not the deposit of miliary nodules along the course of the vessels which causes the danger, but rather the inflammation of the plexus and its products,—the acute effusion of fluid into the

¹ Die Chirurgische Behandlung von Hirn Krankheiten.

brain cavities. The intracranial pressure, through increase of ventricular cerebro-spinal fluid, becomes so great that it offers a hinderance and at last an actual obstruction to the entrance and progress of the blood. Naturally comes the thought to drain off the water, and thereby unburden and free the circulation."

Von Bergmann then describes the similarity of the deposit of miliary tubercle on the pia and peritoneum, both followed by great transudation. The well-known and remarkable results following emptying of the peritoneal cavity with retrogression of the tubercular process lead him to think that the same benefit might accrue in puncturing and draining the ventricles. It was this reasoning that led him to operate, July 15, 1888, upon a case of tubercular meningitis in the stage of brain paralysis.

"The patient lay in a deep stupor, with periods of restlessness and groaning. Pulse 72 and intermittent. Respiration of the Cheyne-Stokes character, with very long intervals. In the contracted left arm convulsions. Eyes closed, pupils dilated, and without reaction. Immediately after the operation, pulse 104, regular; respiration 40 and regular. Evening of same day patient takes nourishment; the eyes are opened, pupils less dilated, and react against light. The patient died, yet the benefit to be derived from the operation was illustrated in a most striking manner."

Dr. W. W. Keen, of Philadelphia, has perhaps done more than any other in bringing the operation into prominence. His achievements have been entirely original, independent of the accomplishments of operators who have antedated his work.

As he states in the paper published in the *Medical Record* of September 20, 1890, he was led, November 7, 1888, to propose the trephining, puncturing, and draining of the lateral ventricles, by the results shown at the autopsy of a case of tubercular meningitis, which had been trephined for supposed abscess, a drainage-tube had been introduced and found post-mortem to reach within one-fourth inch of the distended ventricle, the same having produced no inflammation or irritation.

Dr. Keen reports three cases of his own upon which he did the proposed operation. The first for threatened blindness from acute hydrocephalus, due to tumor of the cerebellum. The left side was first trephined and drained, and some twenty days afterwards the right

side; irrigation of the ventricles, from side to side, without ill result, was demonstrated in this case. This patient died, the post-mortem revealing a sarcoma of the left lobe of the cerebellum.

The second case was one of hydrocephalus of about three years' standing, the mental condition being poor. The left ventricle was tapped, improving paresis of right arm. Convulsions set in next day, thought to be due to too rapid emptying of ventricle. It was decided to replace the fluid, which being done, had the result of stopping convulsions; this was repeated eight times, each time stopping convulsions. The autopsy revealed extensive hydrocephalic distention.

The third case was one of unilateral acute internal hydrocephalus of left ventricle. The patient, being in extremis, died four hours after operation.

Dr. Samuel Ayres, on December 4, 1888, operated upon an imbecile child, five years old, disease beginning during third month of life with convulsions. Enlarged head with closed fontanelles and sutures, aphasia, total blindness, idiotic smiling, rotary movement of head, and grinding of teeth, bowel and bladder incontinence. Had never walked or stood alone. Trephining over coronal suture one and a half inches to right of median line, distinct pulsation, fine trocar introduced through dura downward, backward, and inward to a depth of two and a half inches. One ounce of fluid removed from ventricle, and small quantity from space between dura and brain. Oozing of fluid for several days from puncture in dura. Pulse before operation 120 to 140, after operation, 140; temperature 101.8°. Child could stand alone two or three days after. Partial restoration of sight, would wink on finger being passed before eyes. In three weeks was gradually able to walk alone across room, less irritable, and could sleep well; no development of speech; no control of sphincters. Three months after operation continued improvement.

Dr. Keen reports two cases by Dr. Mayo Robson, of Leeds. The first of these, a boy of ten years, with high temperature, right hemiplegia and aphasia, twitching of limbs of right side, double optic neuritis; operated February 7, 1889, one-and-a-half-inch trephine used over motor centres of right side; no pus being found, a needle was pushed into lateral ventricle, and ten drachms of clear liquid evacuated. Patient showed continual improvement; six months later was in good health. The second case was that of an infant with acute hydrocephalus, drainage and relief to patient, which, however, died the third day after from convulsions.

A. Broca,¹ surgeon to the Hospital of Paris, published two cases under the head of "Drainage of the Ventricles for Hydrocephalus," one of his own, the other by Thiriar, of Brussels. His own case was one of hydrocephalus with contracture of left arm. Drainage of right ventricle, contracture of arm disappeared, object of operation was consequently reached.

Thiriar's was a case of hydrocephalus of three years' standing. Tapping was followed by diminution to circumference of head and a depression of fontanelle. Patient died. Autopsy showed great distention of ventricles.

To these I will add two cases within my own experience.

CASE I.—March 8, 1891, at about 3 P.M., Charles K., a hod-carrier, was struck upon the head by several bricks falling from the second story of a building. He is said to have been completely unconscious immediately after the hurt, gradually regaining partial consciousness; could make efforts at answering questions, and move his limbs. The disability being deemed of a passing nature, he was placed on some boards in the engine room of the building, upon which he had been at work. At five o'clock P.M., two hours after injury, there was so little improvement shown that he was taken to his home, where a physician advised removal to a hospital. He arrived at St. Elizabeth Hospital at 9 P.M. and was placed in my service.

House-surgeon, Dr. Palmer, made note of the following: Still dressed in working clothes, a well-developed, muscular man lay without motion on the table. Pulse 30 to 40, full and irregular; respiration 8 to 10 per minute, irregular and somewhat stertorous. Upon questioning him loudly, he mutters unintelligibly. Pupils dilated, respond feebly to light, and on holding light closely the lids are shut tightly; seems to have good motion on right, diminution in motor power on left side. Owing to great amount of effusion into scalp no definite diagnosis of fracture could be made. Several contusions with great swelling above and in front of right ear.

Upon reaching the patient, the paresis of left side was so marked that it was decided to trephine over right motor centres. After the head was prepared in the usual way, a U-shaped flap beginning at the frontal eminence running backward in median line four inches and returning anteriorly to ear, the flap being about two and a half inches

¹ *Revue de Chirurgie.*

wide. Previous to this, a row of interlocked alternate white and black sutures, about a quarter inch outside line of incision, were tied to control the hæmorrhage. The flap separated from the skull was wrapped in gauze and laid upon the forehead, exposing a linear fracture, commencing a half inch to right of sagittal and the same distance posterior to the coronal sutures, involving the latter suture as far as the incision permitted observation. A one-and-a-half-inch trephine was so placed that the anterior margin reached the coronal suture, and superiorly within a half inch of sagittal suture, and a button of bone removed. No epidural clot or hæmorrhage, but great bulging of the dura, of exceedingly tense feeling and without pulsation. A meningeal artery crossing the trephine opening was tied, and it made the base of a flap in the dura. The brain-substance protruded beyond the skull opening about a quarter inch, and with difficulty replaced. At the moment of bulging pulse and respiration became more rapid; when pressed back pulse and respiration were slower. No subdural clot or hæmorrhage as far as the finger could explore, a normal amount of cerebral fluid escaped. On account of the above conditions a hydrocephalus ventriculi was diagnosticated, and tapping of the ventricles decided upon.

No trocar being on hand, an aspirating-needle, corresponding to No. 3 American catheter scale, was used with syringe attached. The direction of introduction was slightly backward and towards the median line. At a depth of two and a half inches fluid was reached, the syringe was detached from needle, and about three ounces of ventricular fluid gradually drained off. No anæsthetic was given the patient after the incision through the scalp. After the drainage of the ventricle the respirations increased to 16 and pulse to 120 per minute. There was a general reaction, the pupils became smaller, paresis was improved, and the patient was much more sensitive to pain, chloroform being necessary in the latter stages of the operation. No further drainage was employed than a few strands of wicking, which were passed from the point of brain-puncture to the most dependent part of dural and skin-flaps. The button of bone, which had been kept in sterilized water at a temperature of 100° F., was replaced and the scalp brought together with deep, interrupted, and superficial, continued sutures and an aseptic dressing applied. The operation lasted one and three-quarter hours. The following morning respiration was 18 and pulse 120 per minute, temperature 102° F. Patient was comatose, defecated and urinated unconsciously. At 5 o'clock P.M., twenty-six hours after injury and nineteen hours after

operation, temperature rose to 105° , and patient died suddenly, with no marked change in pulse and respiration up to that time.

At post-mortem the dressings were found dry, save slight oozing; edges of scalp united; the pericranium adherent to button of bone; button adherent to dura, and edges of dura united. Upon removal of skull-cap a linear fracture was revealed, beginning as above indicated and extending along the coronal to the sphenoid bone, where it divided into several smaller fractures in the sphenoid and temporal bones. On removal of brain from cranial cavity an epidural clot was found under the squamous portion of temporal bone, there was also a similar sized clot beneath right cerebellar lobe, which lobe was softened to a noticeable degree. The brain and meninges were much congested. The ventricles were empty, and no trace of puncture was found. That the tapping was justifiable was shown by the improvement immediately afterwards. There was sufficient traumatism to cause death. The rise in temperature was ascribed to the extended fractures, disorganization of cerebellar tissue, and resorption of blood-clot.

CASE II.—Freddie McC., aged thirteen, was referred to me by Dr. Brower, to whom I am greatly indebted. The following history was gleaned: Parents respectively forty-two and forty-three years old; in good health; tubercular, specific, or malignant family taint denied. Mother has had but two children,—the patient and a girl aged ten, who is bright, active, and well developed.

Until the age of six years the patient was apparently well, though precocious, attended school, learned quickly and easily, and was apt at acquiring vices and the use of profane language. In disposition he was combative, and was admired by all who knew him for being clever and cute beyond his years.

The history of present trouble began when in sixth year, and extends over a period of several years. At that time he fell from a wagon, striking upon the back of his head. Nothing was thought of the fall, since the patient was at play soon after. He did not become unconscious, nor was there a sign of external injury nor any complaint of resulting pains. Two weeks after he became sick with a fever, which lasted two weeks, was delirious, head was thrown back, and patient at times lay in an opisthotonos position. Intense jaundice developed, the duration of which is unknown. During entire illness there was no incontinence. Convalescence was slow, and during its period of three months patient was fretful and peevish, would cry out in pain, while grasping the head with both hands. He had delusions of varied character, and spoke disconnectedly. In the third month

after beginning of disease patient began to stammer in his speech, and had disordered and involuntary muscular movements and twitchings of face, trunk, and limbs. These increased to the extent that the child was unable to walk or stand, and received many hard blows from falls in consequence. A physician declared it to be chorea. In about one year the patient gained sufficient strength to walk fairly well, but became subject to epileptoid seizures. As when walking or standing the patient would fall and be unconscious for a moment, without convulsive movements; would, however, immediately get up and pursue the subject of occupation. These continued about one year, and were followed by spells during which patient seemed unconscious, the countenance staring, face flushed, followed by pallor. Patient had an ataxic walk, ascending stairs with great difficulty, and was sleepless. The application of faradic current improved both. The power of speech was lost gradually to the extent that only single words could be articulated,—mamma, papa, the name of his little sister, and a few profane words. He was irritable, and would laugh and cry without apparent cause. He was sent to school for a short time, but was unable to acquire anything. There was at the time incontinence of urine and fæces, but at the present time indicates the calls of nature.

The boy is well developed and muscular, thirty-two inches in height, without pubic or axillary hair, which is unusual for a child of that age. The reflexes were found to be normal, except exaggerated knee jerk. The walk is spastic; can walk alone but a few steps. Unilateral symptoms were present, the right side affected more than the left. Has habit of chewing right thumb, upon which callus has formed. Pupils are widely dilated and do not react to light. A critical examination of them cannot be made on account of the restlessness of the subject. Patient has occasional rise in temperature and vomiting. Pulse irregular, from 60 to 70; respiration, 14 to 18, irregular and sighing.

Diagnosis.—Idiocy following hydrops of the ventricles, in turn due to chronic inflammation of the ventricular lining, as a result of cerebro-spinal meningitis. It was proposed to tap the ventricles. After due consideration it was accepted by the parents, to whom the dangers and uncertain results had been explained.

The operation was done May 4, at 11 o'clock A.M., Drs. Luken, Beck, Holland, and McKay being present, besides the house staff. Keen's posterior route for reaching the ventricles was selected, and it was decided to do it upon the left side. The alternate white and black

interlocked hæmostatic sutures were used. A U-shape flap was made and separated from skull, wrapped in gauze, and laid to one side. With a one-and-a-half-inch trephine there was removed a button of bone, the anterior margin one-half inch posterior to coronal suture, the upper margin one and a half inches from sagittal sutures. The button was kept in sterilized water at a temperature of 100° F. The dura opened, a trocar, size No. 3 American catheter scale, was introduced almost directly downward, slightly forward, to base of skull. The ventricle was reached at a depth of one and a quarter to one and a half inches, as was shown by the outpour of clear ventricular fluid, of which six or seven ounces escaped. A grating feel upon the trocar gave the impression that there might be present a ventricular calculus. In order to explore the cavity the handle of a scalpel was passed alongside the trocar, a pair of closed forceps were introduced through the opening then made without being able to detect anything unusual. The index finger was next inserted into the ventricle with no better result. It is, however, noteworthy that this can be done with safety; also that while the finger was in the brain there was great depression, weak and slow pulse and respiration, which improved upon withdrawal. A drainage-tube one quarter of an inch in diameter was passed into the ventricle and through the posterior part of wound. The ventricular fluid flowed freely and with distinct pulsation. The dura was sutured with catgut and button of bone replaced, the scalp coapted and a sterilized dressing applied. Time of operation was two hours. Before removal from the table there was noted a paralysis of right side which persisted until death. The pupil of right eye smaller than left. Patient placed in bed lay very quietly. Passed urine involuntarily, but indicated to his mother when his bowels were to move. He recognized both his father and mother.

On day of operation at 5 P.M., pulse 100; respiration variable and irregular, between 40 and 50; temperature 102° in axilla.

8 P.M., pulse 120; respiration variable and irregular, between 44 and 55; temperature 102° in axilla.

May 5, 8 A.M., pulse 100; respiration variable and irregular, 40; temperature 101.5° in axilla.

3.30 P.M., pulse weak, could not be counted; respiration 56; temperature 100° in axilla.

At 8 P.M. patient was brought to dressing-room to have a new dressing applied, the old being saturated with ventricular fluid. Upon exposure the wound was found in good condition. The edge of the scalp united. The drainage-tube was freely movable, and discharged

clear fluid with distinct pulsation. The external wound was cleansed and dressing applied. Patient seemed more comfortable. At 11.30 P.M. died quietly without convulsions.

Post-mortem was held the morning of the 6th of May. The body was rigid, and the toes of the right foot were extended; the corneæ of both eyes were opaque.

The dressing was removed, and no signs of sepsis were visible here or in any part of the wound. The sutures in the scalp were cut, and slight union was found throughout. There was also slight union between pericranium and cranium, also between cranium and button. Button was adherent to the dura. One catgut suture in the dura had loosened itself. The edges of dura were united, and there was no sign of hernia of the brain. During the entire examination there was a free flow of ventricular fluid.

The cranium was very thick, the button of bone being five-eighths inches in depth. The cranial sutures were raised above the surrounding bone.

The following pathological and anatomical description of brain and meninges was kindly furnished me by Dr. Beck, of this city. The dura mater is much thickened; the inner side is smooth. The inner membranes are nowhere adherent and are easily removed. On the left side of the skull, about four centimetres from the median line and in front of the coronal suture,—in fact, entering it,—is an oblique opening in the skull, about two centimetres in diameter; this was traversed by a band of solid connective tissue, which is united to the pericranium on the outside and the dura internally.

The convolutions of the brain are narrow, especially in the parietal and occipital lobes, some of them being only three and four millimetres broad, but the sulci deep. The convolutions are more ramified than usual, so that the normal configuration of the gyri and sulci is disordered. The island of Reil on both sides is softened, and does not show any distinct gyri. The brain case is normal as regards the array of vessels and nerves.

The gray substance of the brain is very narrow.

Both lateral ventricles, as well as the third, are enlarged to double their normal space. The ependyma shows the most remarkable change, the surface has the appearance of so-called chagrin. The cerebellum is disproportionately large to the cerebrum.

The microscopical examination of a part of tissue taken from the lateral ventricle, where the chagrin tissue is most developed, shows the following from within out. The ependyma is thickened and

undulating; under this is a dense layer of connective tissue, and beneath this a zone of infiltrated leucocytes, both of which are characteristic of a chronic inflammation. The brain-tissue is normal.

Might add that the convolutions along the fissure of Rolando, on the left side, are very much lacking, as can be seen in the specimen. The pathological diagnosis is as follows: A partially-defective cranium, micro-gyri, and a chronic internal hydrocephalus.

To continue the history of the operation, I will add the following:

Dr. W. C. Dugan, before the Louisville Surgical Society, on December 12, 1892, reports the interesting case of a lady, fifty years old, having steadily-increasing great pain in head for eight to ten months. Hearing at first slightly, latterly completely lost. Impairment of intellect, slowness of comprehension and in giving answers. Partial paralysis of right leg, incomplete loss of sensation in right arm, twitching of right side of face. Had two convulsions, whether uni- or bilateral unknown. Ocular examination reveals double-choked disk.

Diagnosis of tumor was made. Probable seat upper part of fissure of Rolando.

Exploratory operation over left parietal region, button of bone removed, allowing dura to bulge greatly, of singularly hard and inelastic feel. The dura opened, brain-tissue welled up as thick as the finger and impossible to return. Hypodermic needle found no fluid, but on grooved director being passed into ventricle three or more ounces of fluid escaped. As the fluid drained off, the brain-tissue receded, and, when completed, the finger could be passed easily between dura and cortex. No tumor was discovered. The grooved director was passed through septum into opposite ventricle without finding fluid. Without drainage the patient was dressed and put to bed. Reacted well without shock. Headache, paralysis, and loss of sensation relieved immediately. Hearing has not returned. As the exact pathology of the accumulation of fluid was not understood, it was thought that the tapping or aspiration may have to be repeated; on that account the button of bone was not replaced.

Dr. Theodore Diller reports a case operated upon by Dr. R. W. Stewart for supposed tumor at base of brain, after an injury two years previous. Diffuse headache, drowsiness, left hemiparesis, cerebellar

titubation, dysphagia, aphonia, and advanced optic neuritis. Operation to relieve intracranial pressure, find and remove tumor if possible. No tumor or depression of bone found, but great bulging and formidable protrusion of brain indicated intracranial pressure. The ventricle was tapped and two ounces of clear fluid removed; drainage. Left paresis more marked after operation, and four or five convulsive seizures. Patient died thirty-six hours afterwards. Tumor, a sarcoma, about the size of a walnut on left side of pons found at post-mortem.

Verified by the results of dissections and trials upon the cadaver, the method of reaching the ventricles has been described in so lucid a manner by W. W. Keen that little can be added to his article published in the *Medical News*, of December 1, 1888. Three routes,—anterior, lateral, and posterior—are given with the minutest details. To this paper I would refer those interested.

In a general way where there is a point of election for reaching the ventricles, either of Keen's routes will make the attainment of the object easy. However, they should not be considered to be the only manner of finding them, nor is it necessary to have recourse to them when the skull has been opened in a different place by injury or disease. From any point on the cerebral cortex it is not very difficult to penetrate to the normal ventricle, familiarity with its location and conformation being the principal requirement. It is extremely easy when the cavity has been enlarged, as in chronic hydrocephalus.

At the post-mortem of Zenner's case, a trial puncture with a trocar three-quarters of an inch to the side of the median line and about one inch anterior to the line connecting the auditory orifices succeeded in reaching fluid at a depth of one and a half inches beyond the dura, but the operator succeeded equally well at several points posterior to this. Broca made a cross incision through the pericranium and trephined three centimetres above and three centimetres behind the right ear meatus, and introduced the trocar in the direction of the opposite ear meatus. He felt the brain consistence yield at a distance of four centimetres, a discharge of clear fluid following.

Thiriar, by experiments on the cadaver, establishes the rule to trephine seven and a half centimetres above the meatus auditorius externus and one centimetre anterior to this line. These

varied rules prove the truth of my previous assertion, that from different points on the cerebral cortex it is not difficult to reach the ventricles.

After the usual aseptic or antiseptic details of preparing the head, a straight crucial or curved incision involving a flap may be made to expose the cranium. A chisel, drill, or trephine, large or small, may be used; if the opening be too small it can be enlarged with proper instruments. The dura may be simply punctured with the trocar, or a dural flap may be made to expose the cerebral surface. This latter has the advantage of allowing of closer observation of the cortex and of finger-exploration between cortex and dura.

The instrument to be used for the puncture is optional with the operator, and the depth to which it will be necessary to penetrate will depend on the amount of fluid in the ventricles.

Zenner used a trocar and found fluid at a depth of one and a half inches. Von Bergmann used a long exploring-needle and introduced it slowly until cerebro-spinal fluid escaped. Keen, at first, used a grooved director, but later cannula, No. 13, French, and thinks it less liable than any other instrument to do damage, which is principally the puncturing of larger vessels. Mayo Robson used a needle and pushed it onward until fluid began to flow. Broca employed the trocar of a Potain aspirator and came upon fluid at a depth of four centimetres. Thiriar made use of a fine rubber cannula closed by a button, and penetrated to the depth of five to six centimetres. I have, in the one case, used the aspirating needle; in the other a fine trocar cannula, No. 3, American. I have devised a cannula with blunt stylet, which will be a useful instrument. In the one case I have penetrated to a depth of two and a half inches, in the other one and a half inches, depending on the amount of distention of the ventricles.

Now, the very important question of drainage arises. Shall it be rapid and free, or slow and in drops, and shall there be irrigation?

The question must be decided for the individual case, as the requirement for each must necessarily differ, depending on the conditions to be met. If the effusion into the ventricles is the result of acute and still active inflammation, decompression

by rapid removal of fluid and subsequent continuous drainage until the acute stage subsides or repeated tapplings without drainage would be the rational procedure. If the inflammation be in the stage of retrogression, the artificial removal of fluid by simple tapping without drainage will be all that is required.

In cerebellar or tumors of other situations, blood-clot from trauma, etc., compressing the circulation to the extent of bringing about a hydrocs ventriculi; if the condition be recent, rapid, and continuous; if it be of longer duration, with great amount of fluid, where the brain-tissue is or may be trephined, tapping and slow continuous drainage or repeated tapplings would seem to be indicated. In chronic hydrocephalus, with great distention of the ventricles, the brain-tissue being atrophied and greatly altered in physical relationship, in order to allow of gradual return to something approaching normal condition, it is best to both tap and drain slowly. That rapid emptying of the ventricles, under these circumstances, is dangerous and may be fatal is well illustrated by Keen's interesting and highly instructive case, No. 2. Finally, in abscess of brain breaking into the lateral ventricles, the most rapid and free drainage and cleansing irrigations is the only procedure promising relief in that most dangerous condition. In these cases it would be best to trephine and drain both sides and irrigate from side to side. That this can be done is demonstrated by Keen's case, No. 1.

Repeated tapplings or aspirations in some cases may advantageously take the place of drainage. The means to secure drainage will be found in rubber tubes of different calibre, gauze, wicking, or horse-hair. In special cases; operative procedure could go further than puncture or drainage, the ventricles may be incised and opened with forceps so that a consistent mass, blood-clot, or foreign body might be removed. In my second case a finger was introduced into the ventricle without any apparent lasting detriment to the patient. This opening up the ventricles freely, probing, and digital examination may be of diagnostic and therapeutic value in special instances.

Although it does not strictly come under the heading of this paper, mention is made of a number of cases of secondary spontaneous opening of the ventricles, from trauma or abscess,

with draining off of cerebro-spinal fluid, for a longer or shorter time. Many of these have recovered, the condition did not add to the gravity of the disease or injury.

Indications.—What is generally understood as brain compression offers the indication for trephining and tapping the ventricles of the brain. That compression can be a sole factor, without other important lesion, in producing death is amply proven by the careful and interesting experiments on animals, and remarkable results obtained by Dr. P. Deuchcr, published in the *Deutsche Zeitschrift für Chirurgie*, Leipzig, 1892, to which I would refer those interested.

It is true, there is no certain method of differentiating compressing agents in the general cavity, the ventricles, or in both together. One such instance has come under my observation, the compressing fluid being drained from the general cavity. Opening of the dura would determine that, perhaps laminectomy, under these circumstances, would be of equal value with trephining.

The compression symptoms have so often been alluded to in the history of the operation that it will not be necessary to repeat them.

In the cases, so well described by Wernicke, of brain compression from simple or tubercular meningitis, decompression by tapping the ventricles offers reasonable hope of restoring brain-function and maintaining its integrity. The symptomatology points to the fact that compression is often the sole element inducing a fatal termination. It is in these acute cases that the operation is of greatest value and urgently demanded. When the skull has been opened for compression symptoms, which are confirmed by bulging of dura and protrusion of brain, no tumor, clot, or depressed bone being found, it is indicated to tap the ventricles. This was shown in my Case, No. 1; in that of Dr. Dugan and that of Dr. Diller. These, although an unrelievable condition underlay the hydrops ventriculi, received an amelioration of the symptoms, as was well illustrated in Dr. Dugan's case. Abscess of brain, which has invaded the ventricles, it is quite clear, demands immediate tapping, and, if possible, irrigation from side to side. This needs no further elucidation or argument. Possi-

ble benefit may be received by tapping chronic hydrocephalus, where there is but little enlargement of head, symptoms denoting a compression, moderate in extent and severity. This was well illustrated in Ayer's case, in which the compressing agent had been at play for over four years.

In tumors of the brain, involving the circulation to the extent of bringing about *hydrops ventriculi*, it is advisable to trephine and tap the ventricle, where the compressing agent has added to the suffering or disability of the patient, or is a proximate cause of danger to life.

But in chronic hydrocephalus, with enlargement of head, with great distention of the ventricles and corresponding atrophy of brain-tissue, it is contraindicated to tap and drain. All cases of this class have died from the operation. One can easily comprehend that under these circumstances no benefit can accrue.

The following summary is offered in conclusion: Trephining and tapping the lateral ventricles,—

(1) For distention of the ventricles from acute, simple or tubercular meningitis, is a therapeutic measure clearly indicated, and other things being equal, promises recovery.

(2) For effusion of blood into the ventricles from trauma or disease, makes recovery a possibility.

(3) For abscess, involving the ventricles, is immediately and imperatively demanded.

(4) For effusion into the ventricles, from brain tumors, may afford relief to symptoms.

(5) For chronic hydrocephalus, moderate distention of the ventricles, without enlargement of head, may afford relief.

(6) For chronic hydrocephalus, great distention of ventricles, enlargement of head, will lead to a fatal result.